Deploying Large Scale SP VoIP Networks

Session 2104
Topics

- Brief Introduction to H.323 and Applications
- Sample Network Scenario
- GK Performance
- Alternate GK Discussion
- Q & A

Example: H.323 Zones
Gatekeeper Mandatory Services

- Address translation
  Translates H.323 aliases or E.164 addresses into IP transport addresses (e.g. 10.1.1.1 port 1720)
- Admissions control
  Authorizes access to the H.323 network
- Bandwidth control
  Manages endpoint bandwidth requirements
- Zone management
  Provides the above functions to all terminals, gateways, and MCUs that register to it

RAS Messages

- GRQ/GCF/GRJ (discovery)
  Unicast—Multicast, find a gatekeeper
- RRQ/RCF/RRJ (registration)
  Endpoint alias/IP address binding, endpoint authentication
- ARQ/ACF/ARJ (admission)
  Destination address resolution, call routing
- LRQ/LCF/LRJ (location)
  Intergatekeeper communication
- DRQ/DCF/DRJ (disconnect)
  Get rid of call state
H.323 Message Exchange

Gatekeeper A

LRQ

LCF

ARQ

ACF

H.225 (Q.931) Setup

H.225 (Q.931) Connect

H.245

RTP

Gateway A

Phone A

IP Network

Gateway B

Phone B

Gatekeeper B

Applications—Single-Stage Dial

Enterprise Application:
Inter-PBX Trunk Replacement (Without Features)

Service Provider Application:
Wholesale Minute Providers
Applications—Two-Stage Dial

- **Service Provider Application:**
  The customer has selected traditional IXC, but dials a number to get access to the bypass provider’s network. After authenticating can make the call to the ultimate destination.

Enterprise Managed Service

- **Service provider application:**
  The Enterprise customer can choose to purchase long distance service, and/or an intracompany VPN service.
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Anatomy of an H.323 Network
Network Dimensioning—How Assumptions Affect Design

Area of Impact

<table>
<thead>
<tr>
<th>Silence suppression</th>
<th>CODEC type</th>
<th>Average Holding Time (AHT)</th>
<th>Header compression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cannot be applied to non-voice applications (e.g. fax)</td>
<td>Bandwidth per call varies by CODEC type (e.g., G.711 bandwidth&gt; 64 kbps)</td>
<td>AHT varies by application, user type, and even market (e.g., fax has shorter AHT than voice)</td>
<td>Reduces bandwidth per call for low-speed links</td>
</tr>
<tr>
<td>Percent reduction in per-call bandwidth will vary by application (e.g., Music on Hold for call center—will not save any BW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Calculating number of GWs:

- Calls/DS0 per hour
  - = (60 min/hour) / (HT)
  - = 60 / HT
  - = 20 BHCA/DS0
- BHCA capacity of AS5300
  - = (DS0/GW) * (BHCA/DS0)
  - = 120 * 20
  - = 2,400 BHCA/GW (0.67 calls/sec)
- # AS5300 GWs needed
  - = (POP BHCA) / (BHCA/GW)
  - = X / 2400 AS5300 needed

Assumptions:
- POP must service X BHCA
- 3 Minute hold times (HT)
- AS5300 GWs can handle up to 2 calls per second
- 120* ports per AS5300
  - * Depends on T1 or E1 and signaling type
### POP Sizing—WAN Bandwidth

**Assumptions:**
- Voice calls
- 120 ports/AS5300
  - Depends on T1/E1 and signaling type
- Voice activity detection 30% efficiency on bandwidth for standard voice calls at T1/E1 levels and up
- G.729 CODEC used
- 60 byte packets + link layer (no header compression)

**WAN Bandwidth/GW:**
- Bandwidth per call
  - 66 bytes * 8 bits/byte * 50 pps = 26.4 kbps
- Total WAN bandwidth/GW
  - 26.4 kbps * 120 (96*) calls/GW = 3.17 Mbps (2.53 Mbps*)
- Assume 30% VAD efficiency
  - 2.53 Mbps * 70% = 2.22 Mbps (1.77 Mbps*)

### POP WAN Sizing With CRTP

**CRTP:**
- Performed on WAN backhaul router (e.g. 3660/7200)
- Reduces IP header from 40 bytes to 2-4 bytes much of the time
- Hop-By-Hop
- Fast/CEF switched cRTP

**WAN Bandwidth:**
- Bandwidth per call (G.729 CODEC):
  - = 12 kbps
- Total WAN bandwidth/GW
  - 12 kbps * 120 (96*) calls = 1.44 Mbps (1.15 Mbps*)
- Assume 30% VAD efficiency
  - = 1.34 Mbps < 1 T1/E1
cRTP Performance 12.1(2)T

![Graph showing Simultaneous Voice Calls (20msec Packetization, 50 PPS / per call)]

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GK Zone Sizing

Number of Busy Hour Call Attempts (BHCA) per GK depends upon:
- GK Platform
- Fault-tolerance features
- Number of registered endpoints
- Dial plan complexity
- Average hold times

Measuring GK Performance

- Call success rate
  99.9% target
- CPU utilization
  60% five minute CPU average
  Accommodate potential CPU bursting to maintain high call success rate
Performance Test—Bed

Orig-DGK  Term-DGK

Orig-GK  Term-GK

GKs under test

Originating Zone  Terminating Zone

12.1(1)T Origination GK Performance

Design Point, 80 CPS with 60% CPU Utilization

CPU Utilization

Calls Per Second
12.1(2)T Origination GK Performance

Terminating GK Performance

Directory GK to Regular GK Ratio Is About 1:4 Based on These Results
Sample Design with Cisco 3660 GK

Test Conditions:
- 10 zones on local GKS
- 540 zone prefixes on terminating GK
- 20 registered gateways
- 10 second hold times
- Cisco IOS 12.1(1)T

To reach this 280,000 BHCA, large number of GWs with 120 ports will be needed. For the following results we reduced the Hold Time to 10 sec. In order to get a high call volume. Recognize that the higher number of GWs will add the additional RAS burden.

GK Zone Sizing Arithmetic for Cisco 3660

Number of AS5300 GWs per 3660 GK:

Straight Calculation
= GK BHCA / GW BHCA
= 288,000 / 2400 (1840*)
= 120 GWs/GK (157 GWs/GK*)
* for T1 PRI

Leaving headroom for registrations (RRQs) and longer hold times (IRRs)
Recommend no greater than 100 GWs/GK

Number of 3660 GKS/Network:
Depends if network originates and/or terminates minutes
Assuming that all calls are Interzone calls and we both originate and terminate:
= (Total GWs) / 100
= [(X / 2400) * 2]/100 GKS
Double this value for HSRP or ALTGK fault tolerance
Sizing Exercise

Given:
- 1,000,000 BHCA network
- Average hold time = 3 minutes
- DS0s per GW will depend on signaling type

<table>
<thead>
<tr>
<th>GW BHCA</th>
<th>T1 PRI</th>
<th>T1 CAS</th>
<th>E1 PRI</th>
<th>E1/R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>1920</td>
<td>2400</td>
<td>2400</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># GWs</th>
<th>(orig&amp;term)</th>
<th># Zones</th>
<th>(orig&amp;term)</th>
</tr>
</thead>
<tbody>
<tr>
<td>544</td>
<td>(1088)</td>
<td>6</td>
<td>(12)</td>
</tr>
<tr>
<td>521</td>
<td>(1042)</td>
<td>6</td>
<td>(12)</td>
</tr>
<tr>
<td>417</td>
<td>(834)</td>
<td>5</td>
<td>(10)</td>
</tr>
<tr>
<td>417</td>
<td>(834)</td>
<td>5</td>
<td>(10)</td>
</tr>
</tbody>
</table>

Sample Network Characteristics

- 1,000,000 Busy Hour Call Attempts (BHCA) spread across various POPs
- Voice and fax calls
- Initial deployment in NY, Chicago, and LA
- Hopoff zone to handle non-locally serviced traffic
- Deploy the rest of the POPs within a year
- 720x routers for backhaul
Directory Gatekeeper

- Introduced in 12.0(3)T
- Creates a hierarchical architecture of GKS
- Eliminates fully-meshed gatekeeper configuration
- Simplifies dial-plan management
- DGKs require approximately one-quarter of the CPU used on local GKS per call
DGK Dial Plan Management

- Minimizes GK Configuration
- Addition Of New Zones
- Addition Of New NPAs
- Addition Of New Rate Centers

Addition Of New Rate Centers

LA
GW #1
Rate Center #1
IntraLATA
Toll
DGK

LA
GW #2
Rate Center #2
DGK

213 West GK
312 MidWest GK
212 East GK
630 MidWest GK

213555…. LA1
213777…. LA2

DGK

312* Chicago
* DGK
630* Chicago

212* NY
* DGK

NY
GW
Local PSTN
East Zone

Chicago
GW
Local PSTN
MidWest Zone

LA
GW #1
Rate Center #1
IntraLATA
Toll
DGK

LA
GW #2
Rate Center #2
DGK

DGK Dial Plan Management

Cisco IOS 12.1(1)T H.323 Call Flow

LRQ
DGK
LRQ
DGK
LRQ
DGK

ARQ
DGK
ARQ
DGK

ACF
DGK
ACF
DGK

H.225 Fast Start Setup
H.225 Fast Start Alerting/Connect

Gateway A
RTP
Gateway B

Limit of Five Recursive Lrqs

Gateway A
Phone A

Gateway B
Phone B
**Detailed Network Diagram**

- **Directory GK**
  - LRQ/LCF
  - HSRP - DGK

- **West Zone**
  - West GK
    - HSRP - DGK
    - RAS

- **Hopoff GK**
  - HSRP - DGK
  - RAS

- **West Zone**
  - LA GW #1
  - LA GW #2

- **Long Distance Network**
  - Hopoff GW

**GW Config—LA1**

- **hostname la1-gw.west.acme.com**
  - aaa new-model
  - aaa authentication login default radius
  - aaa accounting connection h323 start-stop radius

- **isdn switch-type primary-5ess**
  - controller T1 0
  - framing esf
  - clock source line primary
  - linecode b8zs
  - pri-group timeslots 1-24

- **dial-peer voice 1 voip**
  - destination-pattern 1........
  - session target ras
  - precedence 5
  - Repeat until 9........

- **dial-peer voice 213555 pots**
  - destination-pattern 213555....
  - application clid_authen_collect
  - port 0:D
  - prefix 555

- **Repeat for other NPA-NXXs served**

**Gateway**

- **gateway**
  - interface Loopback0
    - ip address 10.10.250.1 255.255.255.0
    - no ip directed-broadcast
    - h323-gateway voip interface
    - h323-gateway voip id gk.west.acme.com ipaddr 10.10.254.10 1719
    - h323-gateway voip h323-id la1-gw.west.acme.com
    - h323-gateway voip tech-prefix 1#

- **interface Ethernet0**
  - ip address 10.10.254.5 255.255.255.0

- **interface Serial0:23**
  - isdn switch-type primary-5ess
  - isdn incoming-voice modem

- **radius-server host 10.1.11.11 auth-port 1645 acct-port 1646**

- **radius-server key testing123**

- **lal-gw.west.acme.com#show gateway**
  - Gateway la1-gw.west.acme.com is registered to Gatekeeper gk.west.acme.com
hostname la2-gw.west.acme.com

! aaa new-model
aaa authentication login default radius
aaa accounting connection h323 start-stop radius
!
! isdn switch-type primary-5ess
!
controller T1 0
  framing esf
clock source line primary
linecode b8zs
pri-group timeslots 1-24
!
dial-peer voice 1 voip
  destination-pattern 2..........
    session target ras
    precedence 5
    Repeat until 9...........
!
dial-peer voice 213777 pots
  destination-pattern 213777.....
    application clid_authen_collect
    port 0:D
    prefix 777
    Repeat for other NPA-NXXs served

interface Loopback0
  ip address 10.10.250.2 255.255.255.0
  no ip directed-broadcast

interface Ethernet0
  ip address 10.10.254.6 255.255.255.0
!
interface Serial0:23
  isdn switch-type primary-5ess
  isdn incoming-voice modem
  !
  radius-server host 10.1.11.11 auth-port 1645
  acct-port 1646
  radius-server key testing123

la2-gw.west.acme.com# show gateway
Gateway la2-gw.west.acme.com is registered to Gatekeeper gk.west.acme.com

Gateway Selection (GK CLI)

- Calls assigned to GWs based on prefix and priority
- GWs with same priority are assigned randomly
- Priority value is between 0–10
  Default value is 5
  Priority 0 do not give any calls to specified GW
  Priority 10 always try specified GW first (if available)

zone local gk.west.acme.com 10.10.253.10
zone prefix gk.west 213555* gw-priority 10 la1-gw
zone prefix gk.west 213777* gw-priority 10 la2-gw
zone prefix gk.west 310*
hostname gk.west.acme.com

interface Ethernet0/0
  ip address 10.10.254.4 255.255.255.0
  standby 1 priority 90
  standby 1 ip 10.10.254.10

! gatekeeper
  zone local gk.west.acme.com acme.com 10.10.254.10
  zone remote gk.directory.acme.com acme.com 10.10.250.10 1719
  zone prefix gk.west.acme.com 213555* gw-priority 10 la1-gw
  zone prefix gk.west.acme.com 213777* gw-priority 10 la2-gw
  zone prefix gk.west.acme.com 310*
  zone prefix gk.directory.acme.com *
  gw-type-prefix 1#* default-technology
  no shutdown

---

gk.west.acme.com#show gate gw-type-prefix
GATEWAY TYPE PREFIX TABLE

=================================
Zone gk.west prefix 213555* priority gateway list(s):
  Priority 10:
    10.10.250.1:1720 la1-gw
  Priority 5:
    10.10.250.2:1720 la2-gw
Zone gk.west prefix 213777* priority gateway list(s):
  Priority 10:
    10.10.250.2:1720 la2-gw
  Priority 5:
    10.10.250.1:1720 la1-gw
Zone gk.west prefix 310* priority gateway list(s):
  Priority 5:
    10.10.250.1:1720 la1-gw
    10.10.250.2:1720 la2-gw
GK Show Commands—West

```
gk.west.acme.com#show gatekeeper endpoints
GATEKEEPER ENDPOINT REGISTRATION
================================
CallSignalAddr  Port  RASSignalAddr   Port  Zone Name   Type    F
--------------- ----- --------------- ----- ---------   ----    -
10.10.250.1     1720  10.10.250.1     4461  gk.west      VOIP-GW
  H323-ID: la1-gw
10.10.250.2     1720  10.10.250.2     4462  gk.west      VOIP-GW
  H323-ID: la2-gw
```

```
gk.west.acme.com#show gatekeeper zone prefix
ZONE PREFIX TABLE
=================
GK-NAME               E164-PREFIX
-------               -----------
gk.west       213555*
gk.west      213777*
gk.west  310*
gk.directory    *
```

GK Config—Hopoff

```
hostname gk.hopoff.acme.com
!
interface Ethernet0/0
  ip address 10.10.253.4 255.255.255.0
  standby 1 priority 90
  standby 1 ip 10.10.253.10
!
gatekeeper
  zone local gk.hopoff.acme.com acme.com 10.10.253.10
  zone remote gk.directory.acme.com acme.com 10.10.250.10 1719
  zone prefix gk.hopoff.acme.com *
  gw-type-prefix 1#* default-technology
no shutdown
```
**GK Show Commands—Hopoff**

```plaintext
gk.hopoff.acme.com#show gatekeeper endpoints
GATEKEEPER ENDPOINT REGISTRATION
=================================
<table>
<thead>
<tr>
<th>CallSignalAddr</th>
<th>Port</th>
<th>RASSignalAddr</th>
<th>Port</th>
<th>Zone Name</th>
<th>Type</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.10.248.1</td>
<td>1720</td>
<td>10.10.248.1</td>
<td>3361</td>
<td>gk.hopoff.acme.co</td>
<td>VOIP-GW</td>
<td></td>
</tr>
<tr>
<td>H323-ID: gw1.hopoff.acme.com</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

```plaintext
gk.hopoff.acme.com#show gatekeeper zone prefix
ZONE PREFIX TABLE
=================
<table>
<thead>
<tr>
<th>GK-NAME</th>
<th>E164-PREFIX</th>
</tr>
</thead>
<tbody>
<tr>
<td>gk.hopoff.acme.com</td>
<td>*</td>
</tr>
</tbody>
</table>
```

**GW Config—Hopoff**

```plaintext
hostname gw1.hopoff.acme.com
aaa new-model
aaa authentication login default radius
aaa accounting connection h323 start-stop radius
isdn switch-type primary-5ess
controller T1 0
  framing esf
  clock source line primary
  linecode b8zs
  pri-group timeslots 1-24

dial-peer voice 2 voip
  incoming called-number 2........
  session target ras
  precedence 5
  Repeat until 9........

dial-peer voice 1 pots
  destination-pattern 2
  port 0:D
  prefix 12
  Repeat until 9

gateway
  interface Loopback0
    ip address 10.10.249.1 255.255.255.0
  h323-gateway voip interface
  h323-gateway voip id gk.hopoff.acme.com ipaddr
  10.10.253.10 1719
  h323-gateway voip h323-id gw1.hopoff.acme.com
  h323-gateway voip tech-prefix 1#

  interface Ethernet0
    ip address 10.10.253.5 255.255.255.0
    no ip directed-broadcast
    ntp broadcast client

  interface Serial0:23
    isdn switch-type primary-5ess
    isdn incoming-voice modem

  radius-server host 10.1.11.11 auth-port 1645
  acct-port 1646

  radius-server key testing123

  gateway gw1.hopoff.acme.com
gw1.hopoff.acme.com#sh gateway
Gateway gw1.hopoff.acme.com is
  registered to Gatekeeper gk.hopoff.acme.com
```
GW Selection (GW CLI)

- Resource Availability Indicator (RAI)
- RAI almostOutOfResources=True/False sent to GK when resources (DS0) low/available
- GK places RAI=True GWs to bottom of GW selection list
- If all GWs in zone have RAI=True, GK will randomly assign calls based on configured priorities
- Specify the high- and low-resource marks

```bash
gw1.hopoff(config-gateway)#resource threshold all high 90 low ? <1-100>  low threshold percentage value
```

DGK Configuration

```bash
hostname gk.directory.acme.com
!
interface Ethernet0/0
  ip address 10.10.250.4 255.255.255.0
  standby 1 priority 90
  standby 1 ip 10.10.250.10
!
gatekeeper
zone local gk.directory.acme.com acme.com 10.10.250.10 1719
zone remote gk.west.acme.com 10.10.254.10 1719
zone remote gk.hopoff.acme.com 10.10.253.10 1719
zone remote gk.east.acme.com 10.10.252.10 1719
zone remote gk.central.acme.com 10.10.251.10 1719
zone prefix gk.west.acme.com 213*
zone prefix gk.east.acme.com 212*
zone prefix gk.central.acme.com 312*
zone prefix gk.central.acme.com 630*
zone prefix gk.hopoff.acme.com *
gw-type-prefix 1#* default-technology
lrq forward-queries
no shutdown
```
DGK Show Commands

```
# show gatekeeper zone prefix
ZONE PREFIX TABLE
===============
GK-NAME   E164-PREFIX
------    -----------
gk.east   212*
gk.central 312*
gk.central 630*
gk.west   213*
gk.hopoff *
```

Useful Debugs

- **Gateway Debugs**
  - debug h225 asn
  - debug h245 asn
  - debug q931
  - debug voip ccapi inout
  - debug ras

- **Gatekeeper Debugs**
  - debug h225 asn
  - debug ras
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12.0(7)T Fault Tolerance

- AltGK on Cisco GWs
  Static definition for two GKs as well as dynamic altGK lists from third-party AltGK partners
  Geographically independent GK failover

  ```
  Gateway(config)# h323-gateway voip gatekeeper-ID ip-address
  priority number
  The priority range is 1 through 127, and the default value is 127.
  ```

- Cisco GK still HSRP only
  Geographic colocation Of gks
  Network unavailable during HSRP failover interval (up to 3 min.)

- Zone fragmentation if static AltGK used with Cisco GKs
Application Zone Interfaces

Release 1: 12.0(7)T
App Server → GK → Packet Network → PSTN
GK-GK Protocol (LRQ) → GK
Empty Capability Set

Release 2: 12.1(1)T
App Server → GK → Packet Network → PSTN
GK API
User-User Protocol (H.450)

Deploying Large Scale SP VoIP Network
Session 2104
Please Complete Your Evaluation Form

Session 2104